

PROCESSING DIAGNOSTIC AND IDENTIFICATION DATA
IN AN ANALOG MODEM SYSTEM

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BACKGROUND OF THE INVENTION

1. TECHNICAL FIELD

The present invention is related to an analog modem system, and more particularly, to an analog modem system in which a second logical channel is used to transmit certain diagnostic data.

2. BACKGROUND INFORMATION

In a typical analog modem system, illustrated in **Figure 1**, one modem 102 connects to another modem 104 via telephone lines 106 to transmit and receive information. In order for the modems to communicate with each other, each modem must first determine what type of modem

with which it is attempting to communicate, in order to, *inter alia*, transmit data at the correct rate, using an optimum protocol.

For a number of reasons, it may be desirable to enable one modem device to identify itself to another modem device during the modem initialization process such that, if the devices are compatible with each other, a number of enhanced features can be prompted or employed. The use of such differentiated features may allow certain compatible modem devices to operate in an improved manner, relative to incompatible modem devices. However, the standard handshake sequences used by two modem devices (typically client and central site modems, although the invention may be used in the context of two client modems or two central site modems) to establish communications have only a limited capability to exchange manufacturer-specific information for system identification, configuration, and diagnostics.

The conventional V.8bis handshake sequence provides some capability to exchange system-specific information during the initial handshake procedure. For instance, some modem manufacturers use this V.8bis handshake sequence to exchange limited diagnostic and identification information. This exchange is only available at the beginning of a call, however, as manufacturers generally do not wish to prolong the handshake sequence. Using the handshake sequence to exchange diagnostic and identification information is generally undesirable, as the user would be sitting and waiting longer for the connection to be established. During the handshake sequence, data is being transmitted at a relatively low rate: until the modems determine the type of modem with which it is communicating, they cannot transmit at their maximum speed. Therefore, it is not desirable to transmit a large amount of data before the handshaking sequence is completed and a data channel is opened.

The manner in which the modem devices exchange the identification data and the type of data exchanged can be varied to address a number of practical issues, *e.g.*, improved performance at a central site ISP location, improved diagnostic information available to the central site ISP location, as well as differentiated features that may be developed in the future.

- 5 The performance associated with a central site may be related to the number of unintentional call disconnections, the number of calls that progress beyond the initial handshaking procedure, the data rates obtained during the connections, and other functional aspects of the modem connections established through the central site.

During the handshaking procedure, it may be desirable to exchange as much information as possible for diagnostic and identification reasons. Such an exchange should consider the duration of the handshake sequence: it is typically undesirable to significantly lengthen the duration of the handshake sequence. Furthermore, the transmission of diagnostic data and identification information should be transparent to the user. In addition, it is desirable to identify the client modem very early in the handshake sequence so that the central site modem can capture the information and utilize it to help diagnose and address connectivity problems in the field. It is thus desirable for a modem to have a short handshake period along with full-featured end-to-end diagnostics. It would be desirable to enhance the ability of the two modem devices to exchange such information, without burdening the initial handshake and thereby delaying the time needed to establish a connection. In addition, it would be desirable to establish the presence
20 of a communications channel between the two modem devices that is available throughout the call, not just at the beginning of the call.

One method for satisfying some of those needs is the installation of a higher-level application program, *e.g.*, an SNMP-based or an HTTP-based application, that can be used for

the exchange of diagnostics, configuration, and the like. However, these types of programs tend to be costly, and, as such, they are not yet widely deployed.

SUMMARY OF THE INVENTION

5 The present invention is directed to a method that satisfies these needs. A method having features of the present invention includes connecting two modems with each other over the telephone lines. Then a handshaking sequence may be performed and identification data may be transmitted between the modems. A primary data channel is opened between the two modems.

Diagnostic and maintenance data may also be transmitted between the two modems. This diagnostic and maintenance data may include customer platform identification data, customer code revision identification data, modem initialization data, a remote query by said first modem of the responses of said second modem to AT commands or other, proprietary, commands, information regarding the status of call waiting, remote network management information, system configuration data, transmitting a command from said first modem to said second modem and transmitting a response from said second modem to said first modem in response to said command, firmware revision data transmitted from one modem to the other modem, uniquely generated call identification data, time information, information regarding the types of modems being connected, and information regarding which telephone line is being used. Unique or pseudo-unique data may also be transmitted or stored that contains information about each
20 connection.

Each of the above-described data may be transmitted on a second logical channel that may be opened after a primary data channel is opened. The second logical channel may be

configured such that, when the second logical channel is used only when the two modems are not using the primary data channel to full capacity.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The invention is further described in connection with the accompanying drawings, where like reference numbers depict like elements, in which:

Figure 1 depicts a typical connection between two modems; and

Figure 2 shows a flow chart of the connection procedure as described in this application;

and

10 **Figure 3** shows a flow chart of the connection procedure of another embodiment described in this application.

DETAILED DESCRIPTION

20 **Figure 2** is a flowchart illustrating the operation of modem system of the present invention. In step 202, two modems are connected to each other. Typically, this step is accomplished when a second modem dials a phone number that is answered by a first modem. The first may belong to a Network Service Provider ("NSP") or an Internet Service Provider ("ISP"), although the first modem may be operated by any number of people or entities. At step 204, the modems perform a handshaking step in which the modems exchange various information. After the handshaking is complete, normal operation of the modem continues at step 206, wherein a data channel is opened at an optimum speed and both the first and second modems transmit and receive data.

Step 204 may be accomplished by using existing V.8bis or other mechanisms (e.g., a combination of V.8bis, V.8, V.25, and/or other features associated with conventional data

communication protocols): the client and central site modems may identify that they are compatible with certain specifications, features, or the like. In addition, the modem devices may exchange an amount of data (e.g., 4 bytes (32 bits) of information) that contains an identification of certain types of data, such as:

- a) A Platform Identifier;
- b) A Controller Revision (if applicable);
- c) A DSP Revision; or
- d) A Firmware Revision.

Both modem devices may transmit a suitable amount of identification data to each other in a bi-directional manner. The identification data may be encoded in accordance with any number of coding algorithms. It should be noted that all of the information can be transmitted, received, and processed without any specific involvement of the end users. The capture of this information during the early part of the handshake can be very helpful in identifying and diagnosing connectivity problems, particularly in connections that fail before communication protocols such as V.42 can be established. It also enables the ISP or NSP to determine if the client modem requires a code update by analyzing any revision data contained in the exchange.

One potential problem that may occur is that non-compatible modems might choose to copy the specific identification codes (or the encoding algorithm) without realizing that such codes may impact the identification process associated with compatible modems. This could lead to misidentification of clients in the field, or misattribution of connectivity problems. One possible solution that could address this concern is to have the central site modem transmit a pseudo-randomly generated code word that is different on each call during the V.8bis exchange. The client modem could run the received code word through a pre-determined scrambler and

transmit it back to the central site. The central site would compare the received code word with what it expects to receive. While it is possible for non-compatible modem manufacturers to discover such encoding techniques, such a discovery would not be easy and would be a time consuming effort. Indeed, the scrambler polynomial and the operation of the identification coding need not be publicized.

The mere exchange of such identification data can be useful for diagnostic and statistical reasons, even if the call is not eventually established. In other words, it may be desirable to obtain and analyze information related to the type, revision, and model of the modems that have performed such an initialization procedure, regardless of whether the modem devices progress to the data mode. Also, once the two modems know that the other is compatible, they may attempt to leverage this information throughout the call by, e.g., transmitting the data in a particular format that is unique to the compatible modems.

BACKGROUND CHANNEL AFTER HANDSHAKE

ITU-T Recommendation V.42 contains provisions for a second logical channel without designating what such channel can be used for. Although V.42 relates to error correction techniques, the second logical channel of V.42 may be utilized in an unrelated manner as a handy background maintenance/diagnostic channel by which the client and central site modems can have a proprietary dialogue. As the end-users are not typically transmitting at maximum rates during the beginning (or even the middle) of a call, there should be sufficient time for a diagnostic exchange to occur in the background without impacting the end users' call setup or use experience. The second logical channel may be used throughout the duration of a call. In the presence of customer data, the second logical channel could have a lower priority than user

data, such that there is no apparent effect on the flow of user data. If no unexpected barriers arise, the second channel could be used to transmit a wide variety of data, including, but not limited to :

- a) Customer platform identifier;
- b) Customer code revision Identifier;
- c) Modem initialization strings, or other configuration information;
- d) Remote Query by the central site of client AT command responses; or
- e) Remote query by the central site of the client for client status outside of standard AT commands through a proprietary diagnostic query/response mechanism; or
- f) Software and driver upgrades.

Note that the transmission of some of this information may require cooperation with the user of the second modem to gather the information. However, it is not desirable to add too much complexity to the client. One approach could be to have the client do a blind "data dump" of information upstream.

Another approach could be to support standard AT commands. In conventional modem systems, AT commands originate with an end user; central site modems are typically not capable of requesting diagnostic information from the client modems. The second logical channel could be utilized to enable the central site modems to specifically query the client modem device using AT commands, without interrupting the data mode. In the alternative, a proprietary diagnostic query/response mechanism may be used to transmit the data. In a similar manner, the client modem can also receive information from the server, such as a firmware revision or a patch to fix a bug.

Since an end user typically does not transmit much data at the beginning of a call in the upstream direction (*i.e.*, from a client site to a central site modem), it is feasible for the client modem to send a "data dump" of desirable information (*e.g.*, manufacturer identification, initiation and dial strings used, status of call waiting disabling, or the like) in the upstream direction. If this information is encoded in a second logical channel, and if the central site modem device properly strips out the second channel, the central site modem can gather this information and route it to higher protocol layers within the remote access concentrator. This information can be utilized for improved remote modem management, among other things.

The present invention is not limited to any specific types or forms of data that may be conveyed by the second logical channel, or the manner in which such data is used by the modem system. In a preferred practical embodiment, the second channel may be used for diagnostics, remote network management, platform/model identification, or system configuration data.

One possible implementation is to have the central site modem use the second logical channel to send an AT command downstream to the client modem. The client could then transmit its response to the command upstream to the central site modem, via the second logical channel. If the user desires to send information upstream, then such transmission may take precedence over the second logical channel, because the secondary channel is given lower priority. Accordingly, the present invention may be implemented without any noticeable effect or disruption to the client user because the secondary channel is only used when the overall data channel has excess capacity.

The operation of this embodiment is illustrated in **Figure 3**. Following connection step 202, handshaking step 204, and opening data channel at step 206, step 308 opens a secondary

logic channel, followed by step 310 in which normal operation of the modem system continues, with data being transmitted on both the primary data channel and the secondary logic channel.

Another possible use of the secondary channel is to uniquely or pseudo-uniquely identify each call through the use of a call cookie. This may be a random or pseudo-random number generated by either the client or the central site modem. This number is associated with the line, time of day, duration, amount of information transmitted and received, and the identification of the modems through database techniques well known in the art. This identifier may be transmitted through the secondary channel at some point during the call. The central site modems may use this information to determine if their modems are operating properly. This information may also be used to determine if a specific combination of line, modem, and service conditions cause performance or connectivity issues. Isolating the connection to specific modems and line conditions can provide valuable information in diagnosing and debugging performance and connectivity issues.

In summary, the use of the V.42 second logical channel can provide a richer and more flexible communication channel than that used during the conventional V.8bis exchange. The second logical channel contemplated by the present invention may be available throughout the duration of the call rather than being restricted to the beginning of the call. The second channel need not interfere with the data being transmitted and received by the end user, because the diagnostic or management data transmitted over such second channel may be designated with a lower priority than user data. In addition, the benefits of the present invention may be realized without purchasing or deploying a complicated "modem management" application.

This level of capability may require the presence of an application such as an SNMP agent, or the applications being offered by various suppliers of diagnostic software. Although

presently these applications are expensive and are not yet common, they can incorporate the above features of the present invention to offer effective and rich remote diagnostics and control of the modem system. For example, once both modem devices have exchanged a suitable amount of identification data, then any number of additional features may be implemented in a manner that leverages such knowledge. In a practical application, the modem devices may
5 utilize different training schemes, retraining schemes, or other functional parameters according to the identification data, which relates to the particular modem devices connected during the given communication session.

In conclusion, it should be appreciated that the description of the present invention herein pertains to preferred embodiments and that the concepts of the invention may be extended to other practical applications. In addition, the current V.8, V.8bis, and V.42 Recommendations, along with any related appendices and attachments, are incorporated by reference herein.

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